(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 311 186 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 88202128.0

(51) Int. Cl.[4]: G02B 6/16 , G02B 6/44

(22) Date of filing: 29.09.88

(30) Priority: 08.10.87 NL 8702395

(43) Date of publication of application:
12.04.89 Bulletin 89/15

(84) Designated Contracting States:
DE FR GB IT NL SE

(71) Applicant: N.V. Philips' Gloeilampenfabrieken
Groenewoudseweg 1
NL-5621 BA Eindhoven(NL)

(72) Inventor: Broer, Dirk Jan
c/o Int. Octrooibureau B.V. Prof. Holstlaan 6
NL-5656 AA Eindhoven(NL)
Inventor: Jochem, Cornelis Marinus Gerrit
c/o Int. Octrooibureau B.V. Prof. Holstlaan 6
NL-5656 AA Eindhoven(NL)
Inventor: Meeuwsen, Theodorus Maria
c/o Int. Octrooibureau B.V. Prof. Holstlaan 6
NL-5656 AA Eindhoven(NL)
Inventor: Vangheluwe, Daniel Cesar Leon
c/o Int. Octrooibureau B.V. Prof. Holstlaan 6
NL-5656 AA Eindhoven(NL)

(74) Representative: Pennings, Johannes et al
Internationaal Octrooibureau B.V. Prof.
Holstlaan 6
NL-5656 AA Eindhoven(NL)

(54) Optical fibre provided with a synthetic resin coating.

(57) An optical fibre provided with a synthetic resin coating, comprising a glass fibre, a first enveloping layer of a synthetic rubber having a modulus of elasticity from 0.1 to 10 MPa and a subsequent enveloping layer of a synthetic resin having a larger modulus of elasticity than the first layer, obtains a large mechanical resistance and a high insensitivity to temperature variations within the range from -60°C to +80°C, in that the thickness of the first layer is from 5 to 20µm and in that the modulus of elasticity of the second layer is more than 1000 MPa.

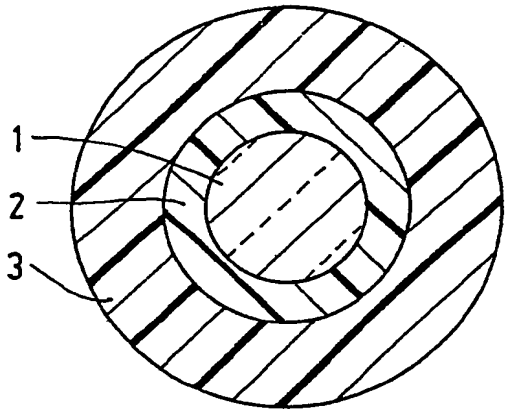

FIG.1

EP 0 311 186 A1

BNSDOCID: <EP_____0311186A1_I_>

Optical fibre provided with a synthetic resin coating.

The invention relates to an optical fibre which is provided with a synthetic resin coating, comprising a glass fibre, a first enveloping layer of a synthetic rubber having a modulus of elasticity of from 0.1 to 10 MPa and a subsequent enveloping layer of a synthetic resin having a modulus of elasticity larger than that of the first layer.

The invention also relates to a method of manufacturing such an optical fibre.

Glass fibres for optical telecommunication purposes are generally covered with a synthetic resin coating to prevent mechanical damage. To prevent optical transmission losses caused by microbends a coating consisting of various layers is preferred. For example, the following method is used. Immediately after the glass fibre has been formed, for example by drawing from a preform or using the double crucible method, a first, soft buffer layer of a synthetic rubber is applied having a modulus of elasticity of from 0.1 to 10 MPa. In order to protect the soft buffer layer during further treatments to which the optical fibre is subjected, a second, harder top layer of a synthetic resin is provided having a modulus of elasticity which exceeds 100 MPa. This top layer is also provided immediately after the glass fibre has been formed, i.e. before the fibre is led over a guide wheel or stored. The buffer layer and the top layer together form the primary synthetic resin coating of the glass fibre. A customary value for the diameter of the glass fibre having a primary synthetic resin coating is 250μm, the diameter of the glass fibre being 125μm.

To protect the optical fibre from ambient influences during cabling, during laying the cables and during the life of the cables, the optical fibre is often additionally provided with a thicker secondary synthetic resin coating having a modulus of elasticity exceeding 1 GPa. This secondary synthetic resin coating is not necessarily applied directly after the formation of the glass fibre.

Two embodiments of such a secondary synthetic resin coating are used. In one embodiment the optical fibre with the primary synthetic resin coating is arranged so as to lie clear off the secondary synthetic resin coating which, hence, forms a tube. The space between the optical fibre and the tube is generally filled with a thixotropic liquid or gel, for example a silicone oil filled with very small quartz particles. It is also possible to accomodate more than one optical fibre in the tube. In the other embodiment the secondary synthetic resin coating is bonded in an adhesive manner to the primary synthetic resin coating.

In European Patent Application EP 155051 a description is given of an optical fibre which is provided with a synthetic resin coating which is formed from a curable synthetic resin composition which is cured by exposure to radiation. The primary synthetic resin coating consists of two layers having moduli of elasticity of from 0.1 to 10 MPa and 100 MPa, respectively. Both layers each have a thickness of approximately 30μm.

It is an object of the invention to provide an optical fibre which is insensitive to external mechanical influences, for example transverse forces on the fibre. The fibre must be largely insensitive to microbending and within the operational temperature range of the fibre (-60 to +80 °C) the mechanical and optical properties must be temperature-independent to the extent possible. Moreover, it is desired to provide an optical fibre, such that the secondary synthetic resin coating can be omitted.

This object is achieved in accordance with the invention by an optical fibre as described in the opening paragraph, which is characterized in that the thickness of the first layer is of from 5 to 20μm and the modulus of elasticity of the second layer exceeds 1000 MPa. The values of the modulus of elasticity are measured at room temperature.

The high value of the modulus of elasticity of the second layer contributes to the mechanical resistance of the optical fibre. An additional advantage is that materials having a high modulus of elasticity generally also have a high glass transition temperature which may even be beyond the field of application of the optical fibre. This contributes to a small temperature dependence of the optical fibre. A practical upper limit of the modulus of elasticity of isotropic synthetic resins without fillers is 3000 MPa. Filling agents are undesired because filling particles may exert a local pressure on the optical fibre, which leads to transmission losses.

The high value of the modulus of elasticity is generally accompanied by a low value of the coefficient of linear thermal expansion, for example 5 to 20 x 10^{-5}/°C. The corresponding values of quartz glass are: 5 x 10^{-7}/°C and of the material of the soft buffer layer: 5 to 40 x 10^{-5}/°C. During the cooling of the fibre, for example after the manufacture or during the use of the fibre, the large differences between the coefficients of linear expansion of the quartz glass and the coating may lead to axial bends in the optical fibre which lead to transmission losses. Moreover, differences between the coefficients of expansion of the top layer and the buffer layer in the radial direction may give rise to bonding problems between the optical fibre and the soft buffer layer. Although the coefficient of linear

RNSDOCID: <EP 0311186A1_I_>

expansion of the synthetic resin coating as a whole is larger than that of the optical fibre which is made from, for example, quartz glass the buffer layer shrinks so much more quickly than the top layer that the buffer layer can be detached from the fibre.

The invention is based on the recognition that the problems occurring by using an extremely rigid material for the top layer can be overcome by selecting the thickness of the first, soft layer so that it is not too large. A thin first layer provides sufficient protection but, unlike a thick layer, it is always subject to compressive stress and it cannot become detached from the optical fibre by shrinkage. Moreover, bending of the optical fibre caused by temperature variations is counteracted to such an extent that the transmission losses caused by bending are small.

The provision of a thin first layer which has to be provided accurately concentrically about the optical fibre is a process which is difficult to control. A method of measuring and controlling the provision of such a thin layer is described in Netherlands Patent Application NL 8701346.

The thickness of the hard top layer is little critical and is preferably selected such that the diameter of the optical fibre with the synthetic resin coating amounts to approximately 250µm. As the diameter of the quartz glass fibre customarily amounts to 125µm, this means that the thickness of the top layer is from 40 to 60µm. A larger thickness of the top layer, such that the total diameter of the fibre with the coating amounts to more than 250µm leads to larger forces which may bring about a bend in the fibre due to variations in temperature.

A method of manufacturing an optical fibre in accordance with the invention is preferably carried out such that both layers are formed from curable synthetic resin compositions which are applied immediately after the optical fibre has been drawn and which are cured by exposure to electrons or UV light. The fibre in accordance with the invention may alternatively be manufactured using a thermally curable synthetic resin composition.

The problem of providing a hard layer of an unfilled synthetic resin is solved in accordance with the invention in that the second hard layer is formed from a curable synthetic resin composition which comprises ethoxylated bisphenol-A diacrylate, isocyanurate triacrylate and at least a polyurethane acrylate.

In a preferred embodiment of the method in accordance with the invention the first soft layer is formed from a curable synthetic resin composition which comprises a polyether urethane acrylate. Synthetic resin compositions which can suitably be used for the manufacture of the buffer layer are described in European Patent Application EP 167199.

The curable synthetic resin compositions used for the manufacture of the buffer layer and the top layer may also comprise other components which are known per se, such as monomeric acrylate compounds to increase the curing rate and to adjust the viscosity, light-sensitive initiators if curing is to be carried out by means of exposure to UV light, catalysts and surface active substances.

In European Patent Application EP 213680 an optical fibre is described the coating of which consists partly of a material which exhibits a high modulus of elasticity in a predetermined preferred direction. In the radial direction the modulus of elasticity is 600 MPa. This material can be used in the secondary and in the primary synthetic resin coating. The thickness of the soft buffer layer is 30µm.

In United States Patent Specification US 3980390 an optical fibre is described which is coated with a 5 to 10 µm thick layer of a synthetic resin which is thermally cured, after which a large number of layers of a thermoplastic material, for example polythene or nylon, having an overall thickness of 50 to 200µm is applied by means of melt extrusion. Such materials are considered unsuitable for the manufacture of strong optical fibres which are independent of ambient influences such as temperature and humidity.

The invention will be explained in greater detail by means of exemplary embodiments and comparative examples and with reference to a drawing, in which

Fig. 1 is a diagrammatic, cross-sectional view of an optical fibre in accordance with the invention,

Fig. 2a-c shows the structural formulae of several polyurethane acrylates,

Fig. 3a-d shows the structural formulae of several monomeric acrylate ester compounds,

Fig. 4a-c shows the structural formulae of two light-sensitive initiators,

Fig. 5 shows the structural formulae of mono and di-2-acryloyl ethoxy phosphate, wherein x = 1 and x = 2, respectively, and in which

Fig. 6 shows the structural formula of ethoxylated bisphenol-A diacrylate,

which compounds can suitably be used in the method in accordance with the invention.

EXEMPLARY EMBODIMENT 1

A multimode glass fibre is formed in known manner by drawing from a preform. A glass fibre is to be understood to mean herein a fibre of glass or quartz glass. The fibre comprises a core glass and

BNSDOCID: <EP_____0311186A1_I_>

a cladding glass having different refractive indices (not shown in Fig. 1). Alternatively, a fibre can be used having a refractive index which varies gradually from the inside outwards, and instead of a fibre drawn from a preform a fibre can be used which is manufactured by means of the double crucible method. A glass fibre 1 shown in Fig. 1 has a circular cross section (diameter 125µm) but the cross section may also have any other shape.

Immediately after the glass fibre 1 has been formed, it is provided with a layer of a curable synthetic resin composition which is subsequently cured, thereby forming a buffer layer 2 of a synthetic rubber having a thickness of 11µm. A method of applying thin layers to an optical fibre is described in United States Patent Specification US 4644898.

The curable synthetic resin composition contains as the main constituent (68 % by weight) a polyether urethane acrylate as described in European Patent Application EP 167199, shown in Fig. 2a, wherein n has an average value of 120. The curable synthetic resin composition further comprises the reactive monomers 2-phenoxy-ethyl pro acrylate (20 % by weight, see Fig. 3a) and tri pylene glycol diacrylate (6 % by weight, see Fig. 3b), the light-sensitive initiator 2,2-dimethoxy-2-phenyl-acetophenone (2 % by weight, see Fig. 4a) and p-chloro-benzophenone-2-ethoxy-ethylacrylate (2 % by weight, see Fig. 4c). Finally, the curable synthetic resin composition contains 2 % by weight of a mixture of mono and di-2-acryloyl ethoxy phosphate in a molar ratio of 1:1, see Fig. 5. Other curable synthetic resin compositions such as, for example, polysiloxanes, can also suitably be used in the buffer layer of the synthetic resin coating of the glass fibre in accordance with the invention.

The curable synthetic resin composition is made to cure by means of radiation using a high pressure mercury discharge lamp which produces predominantly UV light having wavelengths from 200 to 400 nm and an intensity of 0.27 W/cm^2, measured on the synthetic resin layer, during maximally 0.5 s. The curable synthetic resin composition can also be cured in an other way, for example, by exposing it to electron radiation, in which case the curable synthetic resin composition need not comprise a light-sensitive initiator. After curing, the modulus of elasticity of the material of the buffer layer is 1.3 MPa at room temperature. The refractive index is 1.4808. The coefficient of linear expansion is 23 x 10^{-5}/°C at temperatures exceeding -5 °C and decreases at lower temperatures to a value of 10 x 10^{-5}/°C at -60 °C.

Subsequently, a second layer of a synthetic resin 3 is applied to the fibre (see Fig. 1) in a thickness of 52µm, by covering the fibre with a curable synthetic resin composition which is subsequently made to cure by exposure to UV light. A suitable synthetic resin composition for this second layer (top layer of the primary synthetic resin coating) comprises 19.1 % by weight of a polyester urethane acrylate as shown in Fig. 1b, 23.9 % by weight of isocyanurate triacrylate (see Fig. 3c), 4.5 % by weight of 2,2-dimethoxy-2-phenyl-acetophenone (see Fig. 4a) and 52.5 % by weight of ethoxylated bisphenol-A diacrylate (see Fig. 6). After curing, the modulus of elasticity of this material is at -60 °C: 1995 MPa, at +20 °C: 1585 MPa and at +80 °C: 501 MPa. The refractive index at 20 °C is 1.5279. The glass transition temperature T_g is approximately 100 °C. The coefficient of linear expansion is 5 x 10^{-5}/°C at temperatures below -5 °C and increases at higher temperatures to a value of 18 x 10^{-5}/°C at +80 °C.

The optical fibre thus manufactured, in the present example a multimode fibre, is subjected to a number of tests in which the transmission loss is measured. A compression test is carried out in which a piece of fibre having a length of 0.5 m is clamped between two flat plates with a clamping force of 50 kPa. One of the two plates is provided with 12 grooves having sharp edges. Under these conditions and at a wavelength of light of 850 nm the fibre in accordance with this exemplary embodiment shows the following increase of the losses: 0.38 dB at -60 °C, 0.19 dB at +20 °C and 0.18 dB at +80 °C.

In the stress-free condition, the transmission loss caused by changes in temperature and expansion is, relative to room temperature is 0.2 dB/km at -60 °C and less than 0.05 dBkm at -55 °C and +80 °C.

EXEMPLARY EMBODIMENTS 2 AND 3

Optical fibres are manufactured and coated in the same manner as described in exemplary embodiment 1, with this difference that monomode fibres are used. The thickness of the buffer layer is 12 or 19µm, the thickness of the top layer is 50 or 43µm, respectively.

In the stress-free condition the transmission loss, caused by changes in temperature relative to room temperature is 0.0 dB/km at -60 °C and +80 °C, measured at a wavelength of light of 13.00 nm.

The sensitivity of the optical fibre before it is subjected to transverse forces is measured by winding 150 m of optical fibre on a cylinder, having a diameter of 0.5 m, which is covered with abrasive paper (no. 120). The winding force is 2 N. The increase of the transmission loss as a consequence of this treatment is 0.1 dB/km at wavelengths of light of 1300 nm and 1550 nm, and 0.6 dB/km at

BNSDOCID: <EP_____0311186A1_I_>

1700 nm, at a thickness of the buffer layer of both 12µm and 19µm.

EXEMPLARY EMBODIMENT 4

An optical fibre is manufactured and coated in the same way as described in exemplary embodiment 1, the thickness of the buffer layer being 8µm and of the top layer 55µm. The top layer is made from a curable synthetic resin composition which consists of 10 % by weight of a polyester urethane acrylate as shown in Fig. 1c, 18 % by weight of isocyanurate triacrylate (see Fig. 3c), 10 % by weight of an epoxy acrylate (see Fig. 3d), 4 % by weight of 1-hydroxy cyclohexylphenylketone (see Fig. 4b) and 58 % by weight of ethoxylated bisphenol-A diacrylate (see Fig. 6). After curing, the modulus of elasticity of this material is 1420 MPa at room temperature.

COMPARATIVE EXAMPLE 5, NOT IN ACCORDANCE WITH THE INVENTION

A monomode optical fibre is manufactured as described in exemplary embodiment 1, with this difference that no buffer layer is applied.

In the stress-free condition the transmission loss, caused by temperature variations relative to room temperature is 0.0 dB/km at -60 °C and +80 °C, measured at a wavelength of light of 1300 nm.

The transverse-load sensitivity is measured by means of the abrasive-paper test. The increase of the transmission loss is 1.3 dB/km at a wavelength of light of 1300 nm, 2.0 dB/km at 1550 nm and 3.1 dB/km at 1700 nm.

In this comparative example, the temperature sensitivity of the optical fibre is small, but the transverse-load sensitivity is undesirably large.

COMPARATIVE EXAMPLES 6 AND 7, NOT IN ACCORDANCE WITH THE INVENTION

Multimode optical fibres are manufactured as described in exemplary embodiment 1. The thickness of the buffer layer is 27 or 35µm, the thickness of the top layer is 36 or 27µm, respectively.

When the fibre having a buffer layer of 35 µm is subjected to a compression test as described in exemplary embodiment 1, the transmission loss is 0.05 dB at room temperature and a wavelength of light of 850 nm.

In the stress-free condition the transmission loss, caused by temperature variations relative to room temperature is, at -60 °C and a wavelength of light of 850 nm, 1.0 dB/km for the optical fibre having a buffer layer of 27µm and more than 10 dB/km for the fibre having a buffer layer of 35µm. Both fibres have an additional transmission loss of less than 0.05 dB/km at a temperature of +80 °C.

The load sensitivity is small but the fibres in accordance with the present comparative example are sensitive to temperature variations, in particular to cooling, to an undesirably large extent.

COMPARATIVE EXAMPLES 8 AND 9, NOT IN ACCORDANCE WITH THE INVENTION

Monomode optical fibres are manufactured as described in exemplary embodiment 1. The thickness of the buffer layer is 24 or 33µm, the thickness of the top layer is 39 or 30µm, respectively.

The transverse-load sensitivity of the fibre having a buffer layer of 33µm is measured by means of the abrasive paper test. The increase of the transmission loss is less than 0.05 dB/km at a wavelength of light of 1300 or 1550 nm, and 0.1 dB/km at 1700 nm.

In the stress-free condition, the transmission loss caused by temperature variations relative to room temperature is, at -60 °C and a wavelength of light of 1300 nm, 0.8 dB/km for the fibre having a buffer layer of 24µm and more than 4 dB/km for the fibre having a buffer layer of 33µm. Both fibres have an additional transmission loss of 0.0 dB/km at a temperature of +80 °C.

The transverse-load sensitivity is small but the fibres in accordance with this exemplary embodiment are sensitive to temperature variations, in particular to cooling, to an undesirably large extent.

COMPARATIVE EXAMPLE 10, NOT IN ACCORDANCE WITH THE INVENTION

A multimode optical fibre is manufactured as described in exemplary embodiment 1. The thickness of the buffer layer is 33µm, the thickness of the top layer is 32µm. The buffer layer is manufactured from a commercially available synthetic resin composition, DeSolite 039^{R} by DeSoto Inc., the top layer is manufactured from DeSolite 042^{R} by DeSoto Inc. Both synthetic resin compositions comprise a light-sensitive initiator. After curing, the modulus of elasticity of Desolite 042^{R} is at -60 °C: 1585 MPa, at +20 °C: 398 MPa and at +80 °C: 13 MPa.

In the stress-free condition, the transmission loss caused by temperature variations relative to room temperature is, at a wavelength of light of 850 nm, 0.1 dB/km at -60 °C and less than 0.05 dB/km at +80 °C.

BNSDOCID: <EP_____0311186A1_I_>

In a compression test as described in exemplary embodiment 1, at a wavelength of light of 850 nm, the additional transmission loss is 0.69 dB at -60° C, 0.21 dB at +20° C and 0.37 dB at +80° C. The fibre in accordance with this exemplary embodiment has an undesirably large sensitivity to mechanical load.

COMPARATIVE EXAMPLE 11, NOT IN ACCORDANCE WITH THE INVENTION

A monomode optical fibre is manufactured by means of the synthetic resin compositions described in comparative example 10. The thickness of the buffer layer is 32µm, the thickness of the top layer is 33µm.

In the stress-free condition, the transmission loss, caused by temperature variations relative to room temperature is, at a wavelength of light of 1300 nm, less than 0.05 dB/km at -60° C and 0.0 dB/km at +80° C.

The transverse-load sensitivity of the optical fibre is measured by means of the abrasive paper test. The increase of the transmission loss is 1.3 dB/km at a wavelength of light of 1300 nm, 2.7 dB/km at 1550 nm, and 5.5 dB/km at 1700 nm. The fibre in accordance with this exemplary embodiment is very sensitive to transverse loads.

The examples show that an optical fibre having a large resistance to mechanical load and a high insensitivity to temperature variations can only be obtained by using a synthetic resin coating which consists of a top layer having a high modulus of elasticity and a soft buffer layer which must be thin but not inexistant. The critical thickness, which is not to be exceeded depends on the difference in thermal expansion between the buffer layer and the top layer.

Claims

1. An optical fibre which is provided with a synthetic resin coating, comprising a glass fibre, a first enveloping layer of a synthetic rubber having a modulus of elasticity of from 0.1 to 10 MPa, and a subsequent enveloping layer of a synthetic resin having a modulus of elasticity larger than that of the first layer, characterized in that the thickness of the first layer is of from 5 to 20µm and the modulus of elasticity of the second layer is more than 1000 MPa.

2. A method of manufacturing an optical fibre as claimed in Claim 1, characterized in that both layers are formed from curable synthetic resin compositions which are applied immediately after the optical fibre has been drawn and which are made to cure by exposure to electrons or UV light.

3. A method as claimed in Claim 2, characterized in that the second hard layer is formed from a curable synthetic resin composition which comprises ethoxylated bisphenol-A diacrylate, isocyanurate triacrylate and at least one polyurethane acrylate.

4. A method as claimed in Claim 2, characterized in that the first soft layer is formed from a curable synthetic resin composition comprising at least one polyether urethane acrylate.

BNSDOCID: <EP 0311186A1_I_>

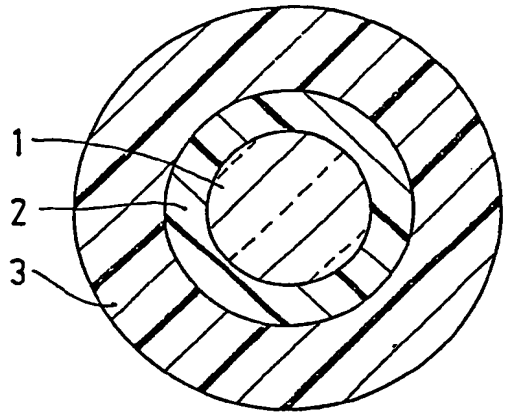

FIG.1

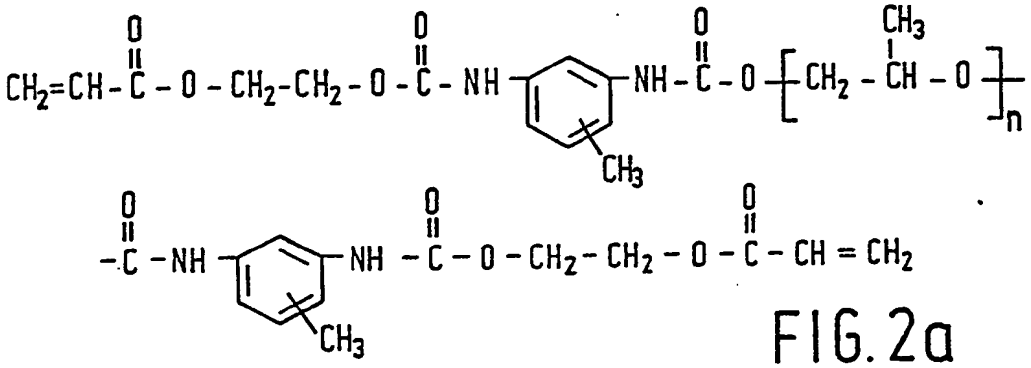

FIG.2a

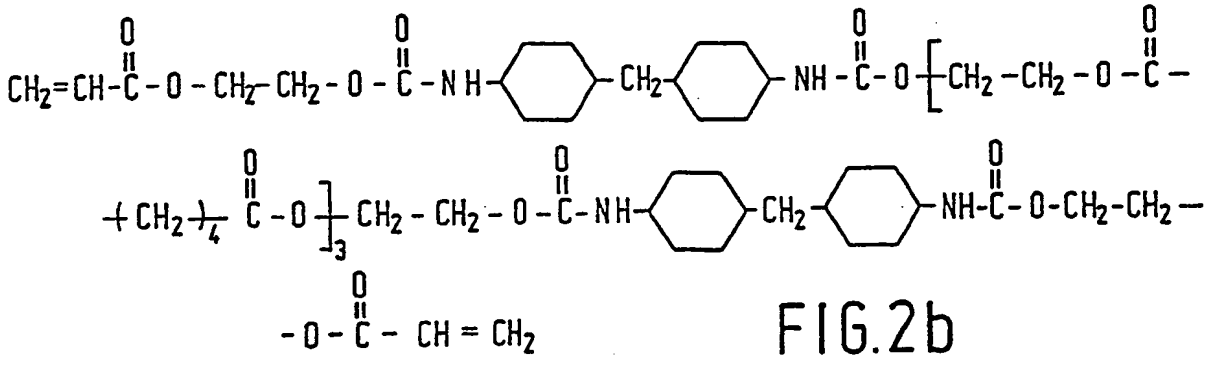

FIG.2b

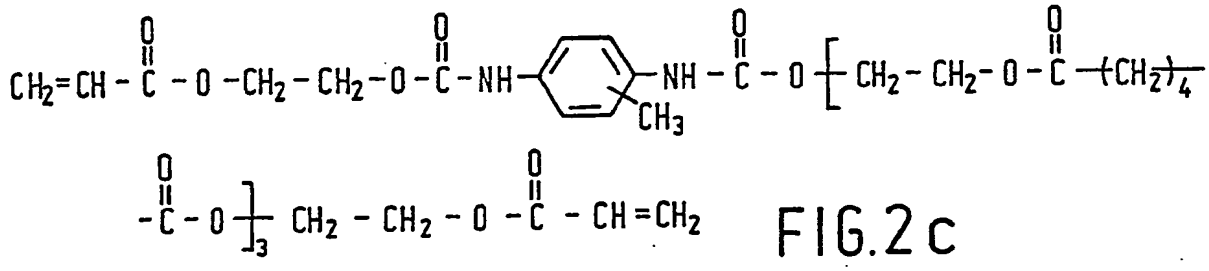

FIG.2c

BNSDOCID: <EP_____0311186A1_I_>

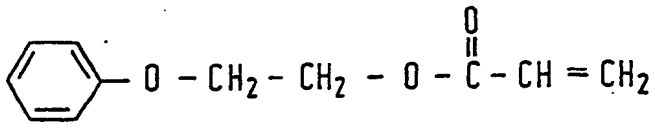

FIG. 3a

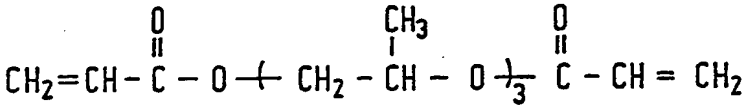

FIG. 3b

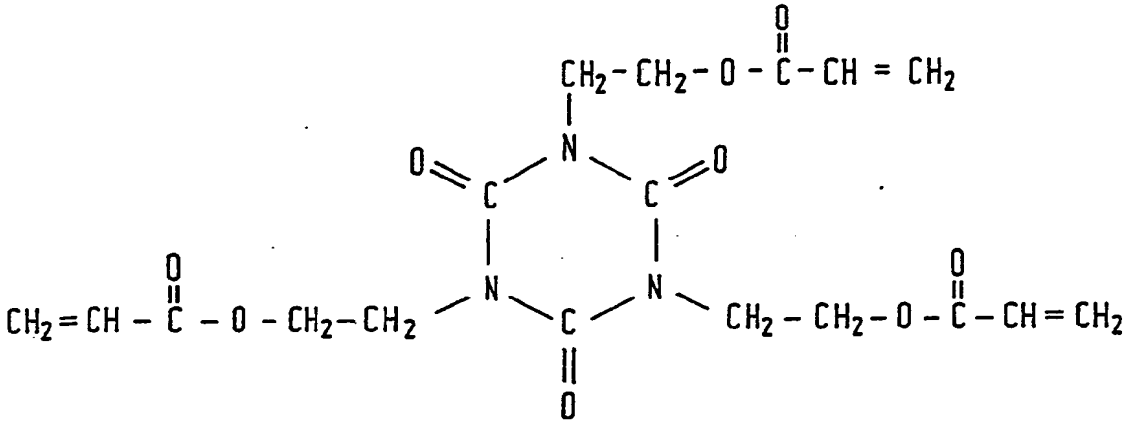

FIG. 3c

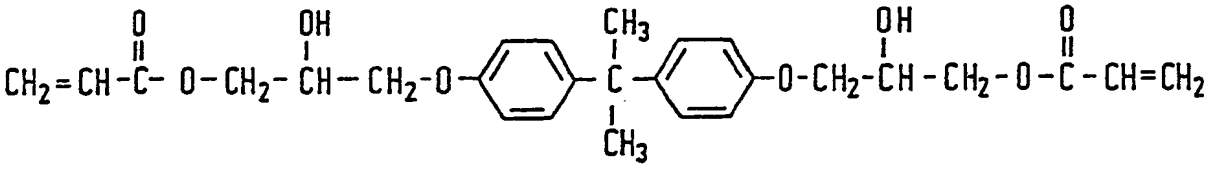

FIG. 3d

RNSDOCID: <EP 0311186A1_I_>

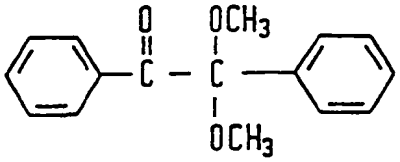

FIG. 4a

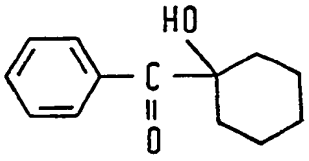

FIG. 4b

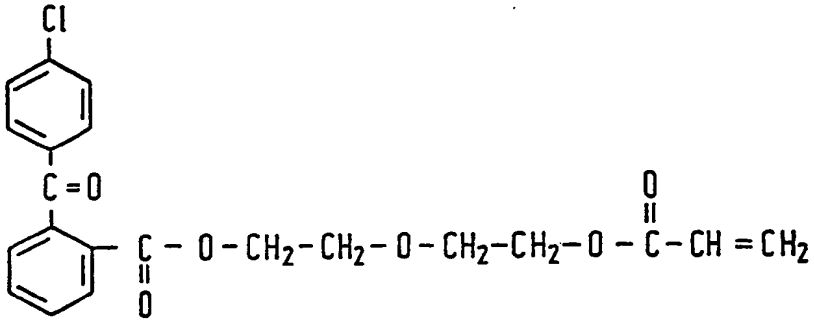

FIG. 4c

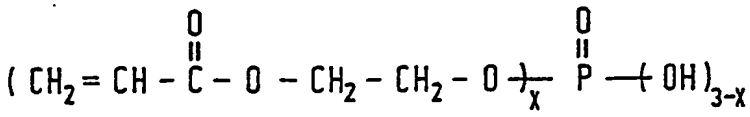

FIG. 5

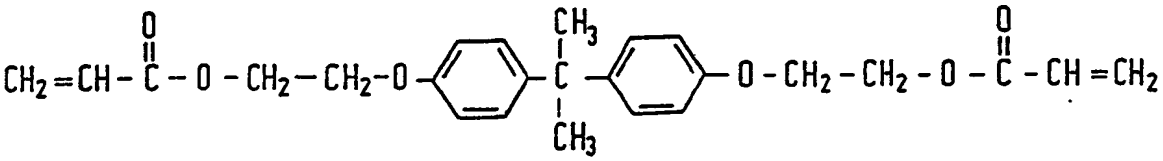

FIG. 6

BNSDOCID: <EP_____0311186A1_I_>

Europäisches Patentamt

EUROPÄISCHER RECHERCHENBERICHT

Nummer der Anmeldung

EP 88 20 2128

EINSCHLÄGIGE DOKUMENTE

Kategorie	Kennzeichnung des Dokuments mit Angabe, soweit erforderlich, der maßgeblichen Teile	Betrifft Anspruch	KLASSIFIKATION DER ANMELDUNG (Int. Cl.4)
Y	DE-A-3 147 137 (SIEMENS AG) * Insgesamt *	1,2	G 02 B 6/16 G 02 B 6/44
Y	EP-A-0 140 415 (PHILIPS) * Seite 5, Zeile 27 - Seite 7, Zeile 38; Figuren 1-6 *	1-4	
D,A	EP-A-0 155 051 (PHILIPS) * Seite 7, Zeile 4 - Seite 10, Zeile 7; Figuren 1-3 *	1-4	
D,A	EP-A-0 167 199 (PHILIPS) * Insgesamt *	1-4	
A	PATENT ABSTRACTS OF JAPAN, Band 8, Nr. 254 (P-315)[1691], 21. November 1984, Seite 147 P 315; & JP-A-59 126 504 (FURUKAWA DENKI KOGYO K.K.) 21-07-1984	1-4	

RECHERCHIERTE SACHGEBIETE (Int. Cl.4)

G 02 B 5/00
G 02 B 6/00
C 03 C 25/00

Der vorliegende Recherchenbericht wurde für alle Patentansprüche erstellt

Recherchenort	Abschlußdatum der Recherche	Prüfer
DEN HAAG	15-11-1988	SARNEEL A.P.T.

KATEGORIE DER GENANNTEN DOKUMENTE

X : von besonderer Bedeutung allein betrachtet
Y : von besonderer Bedeutung in Verbindung mit einer anderen Veröffentlichung derselben Kategorie
A : technologischer Hintergrund
O : nichtschriftliche Offenbarung
P : Zwischenliteratur

T : der Erfindung zugrunde liegende Theorien oder Grundsätze
E : älteres Patentdokument, das jedoch erst am oder nach dem Anmeldedatum veröffentlicht worden ist
D : in der Anmeldung angeführtes Dokument
L : aus andern Gründen angeführtes Dokument

& : Mitglied der gleichen Patentfamilie, übereinstimmendes Dokument

EPO FORM 1503 03.82 (P0403)

RNSDOCID: <EP 0311186A1_I_>